Tevatron Halo Removal

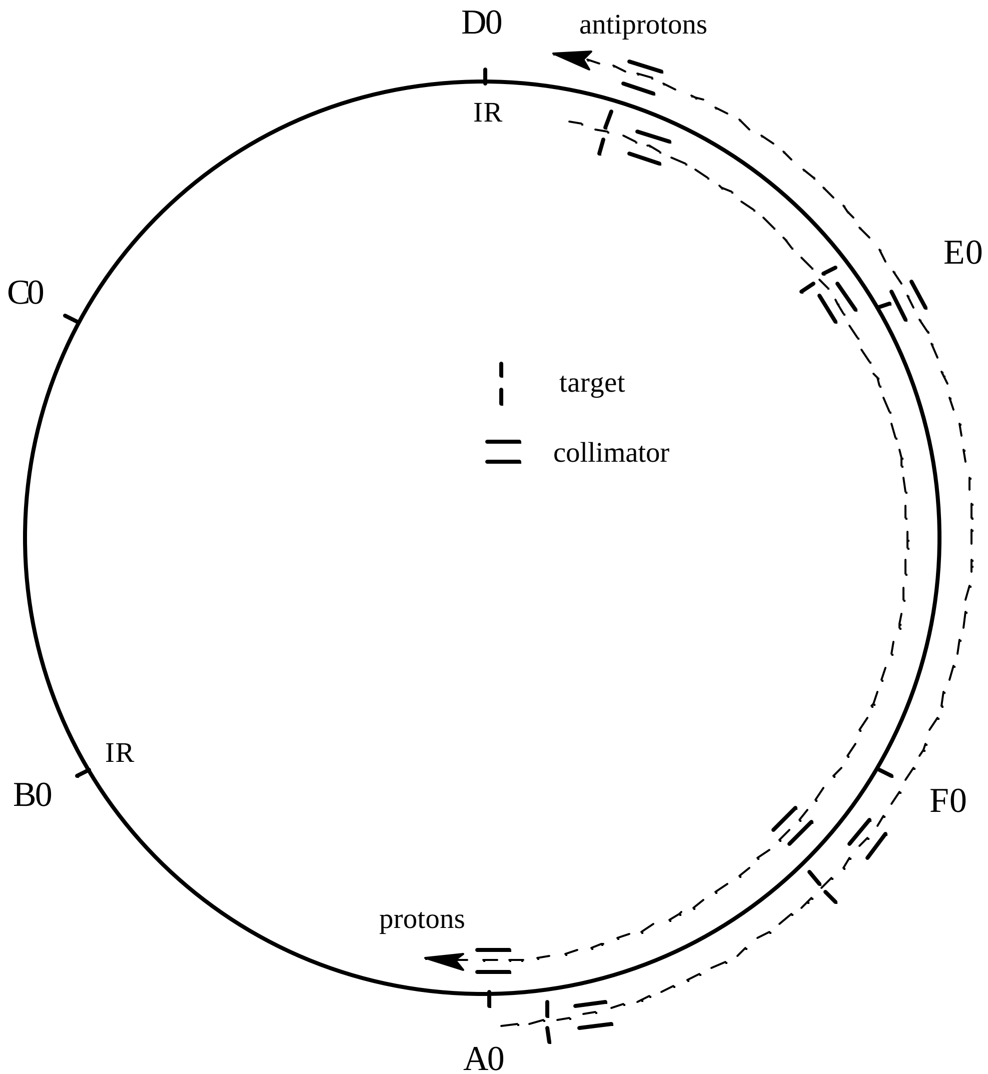
Dean Still 5/22/00

- Quick Collimator System Overview.
- Some Observations and Study Results Related to Large Proton Backgrounds at CDF and D0.

Collimator System Upgrades for CRII

- **Wanted to move to commercial hardware to replace in house motion controls.**
  - Collimators are faster and more reliable.
  - Each Collimator would be able to do feedback processing.
- **Wanted to move to a more automated system to reduce shot setup time and integrate with the Collider Sequencer.**
  - Goal was to shot setup Halo Removal times of about 5 min.
- **Wanted to move to a 2 stage collimator Halo removal system.**
  - Build 4 new targets and 8 new secondary collimators .
- **Wanted to employ a Proton removal system.**
  - Build 1 new proton removal collimator and E0 dogleg system.
  - Goal was to remove 1E13 in 100 secs.

Tevatron Collimator Layout



Collimator Groups

<u>Proton Set 1</u>

D49 target
E03 collimator
F172 collimator

<u>Proton Set 2</u>

D171 target
D173 collimator
A0 collimator

<u>Pbar Set 1</u>

F49 target
F48 collimator
D172 collimator

<u>Pbar set 2</u>

F173 target
F171 collimator
E02 collimator

Green = Currently operational

Lattice Parameters for Collimator Locations for Collider II

collimator	protons ϕ_x (deg) (mod 360)	protons ϕ_y (deg) (mod 360)	antiprotons ϕ_x (deg) (mod 360)	antiprotons ϕ_y (deg) (mod 360)	β_x (m)	β_y (m)	D_x (m)	beam separation x (mm)	beam separation y (mm)
D17 target	0	0	326	349	87	34	5.7	4.4	1,9
D17(2)	6	12	320	337	63	47	4.9	3.5	2.7
D17(3)	8	14	318	335	58	52	4.7	3.2	2.9
D49 target	171	187	156	153	88	75	1.8	5.0	3.1
E0(1)	183	195	143	142	59	94	1.7	3.6	4.1
E0(2)	213	225	112	123	96	59	2.3	2.2	4.4
E0(3)	214	227	111	121	99	59	2.4	2.1	4.4
F17(1)	148	167	177	182	91	32	5.9	5.6	1.0
F17(2)	149	169	176	179	85	35	5.7	5.4	1.2
F17 target	156	180	170	168	61	50	4.9	4.6	2.1
F48	312	302	14	46	99	29	1.8	5.7	1.4
F49 target	326	349	0	0	179	40	2.5	7.9	1.3
A0	331	14			160	61	2.6	7.4	3.2

Collimator Controls Hardware

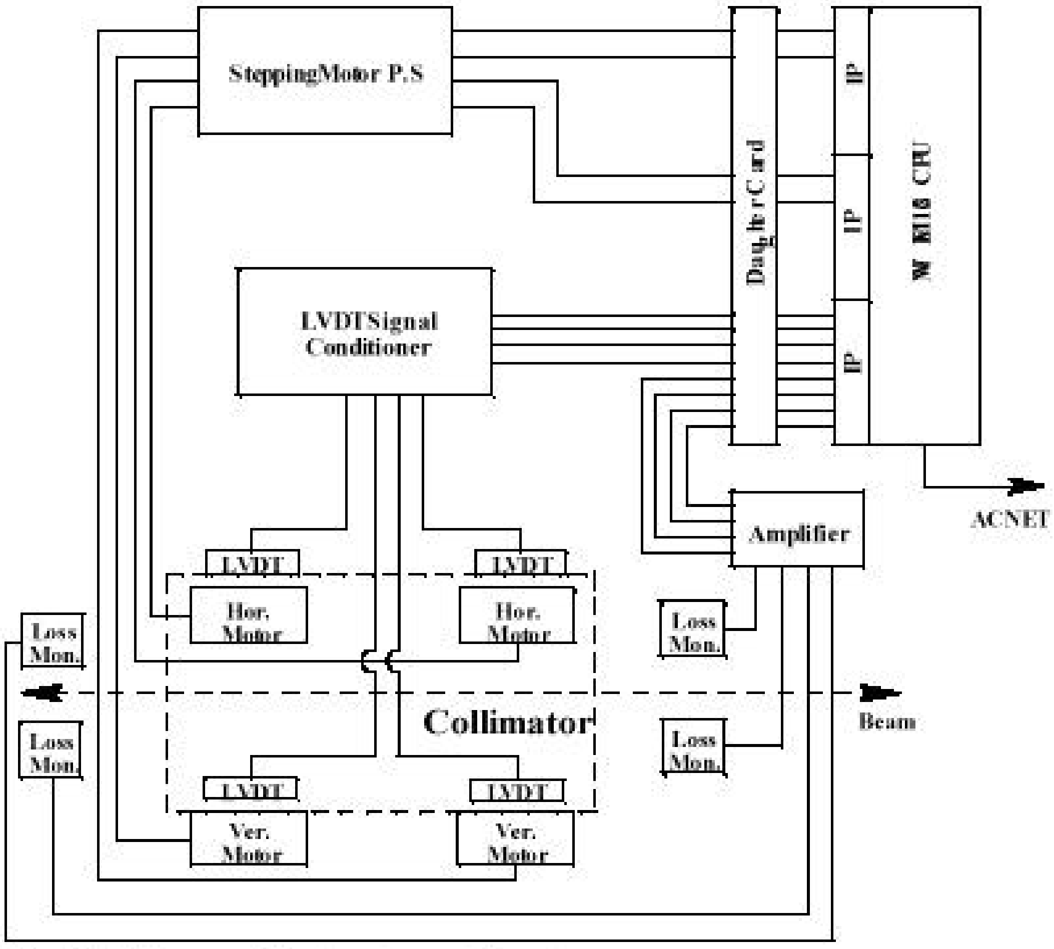
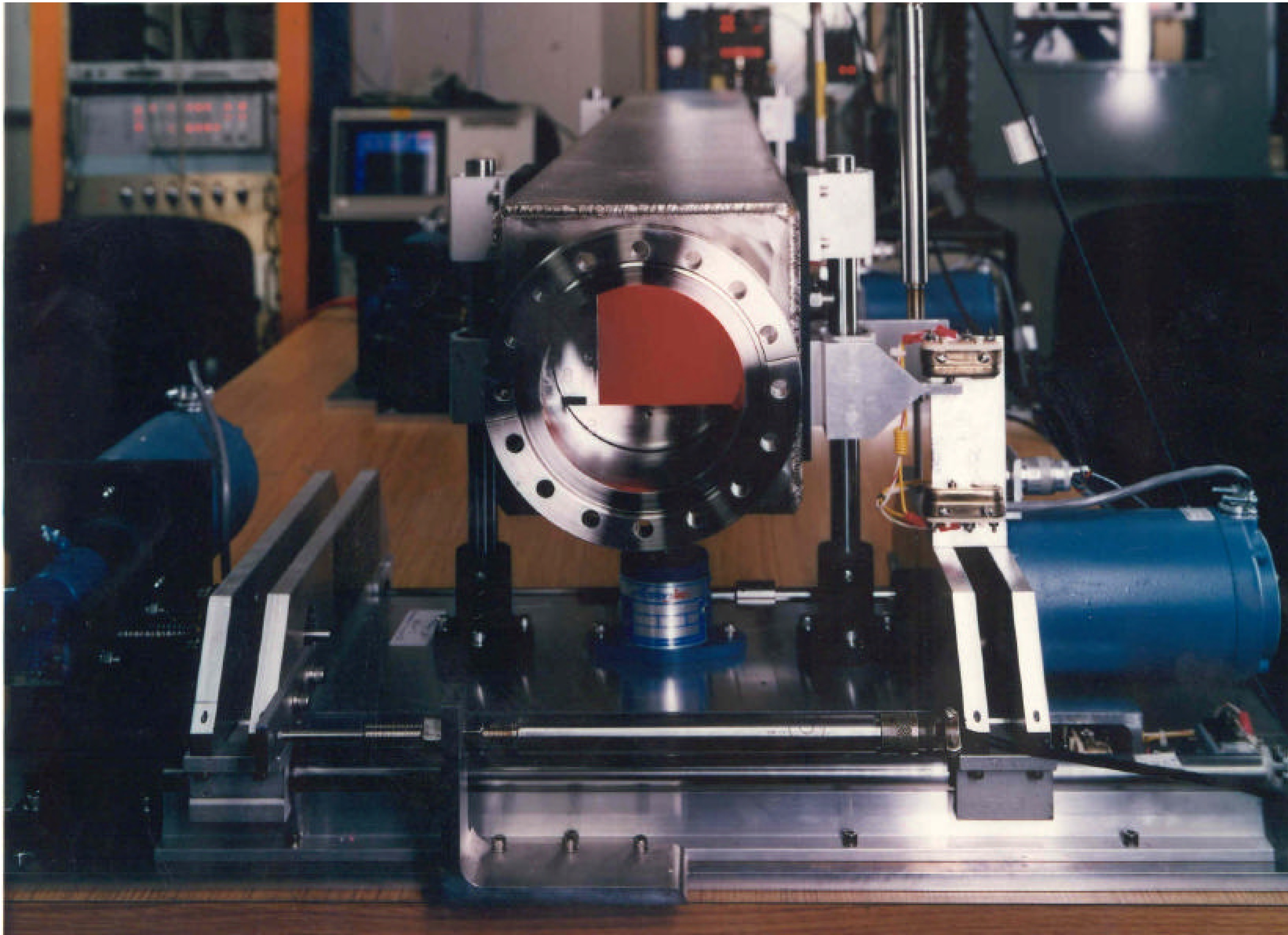


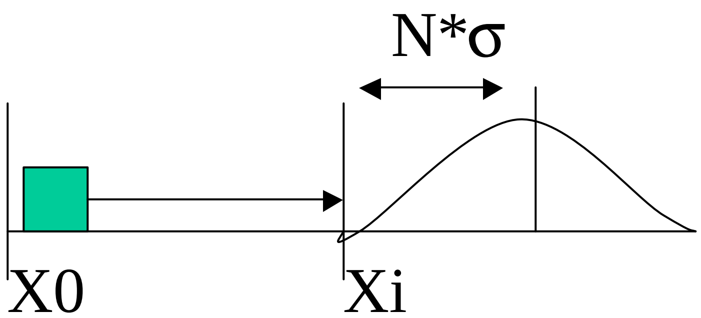
Figure 6.64. Block diagram of collimator control system

Collider II 1.5m Collimator



Collider II 1.5m Collimator

Overview of New Software



Front End

Fast Processing :

Loss Monitor & Intensity Feedback.

OAC

Global Orchestration:

Employs states and collimator moving map.

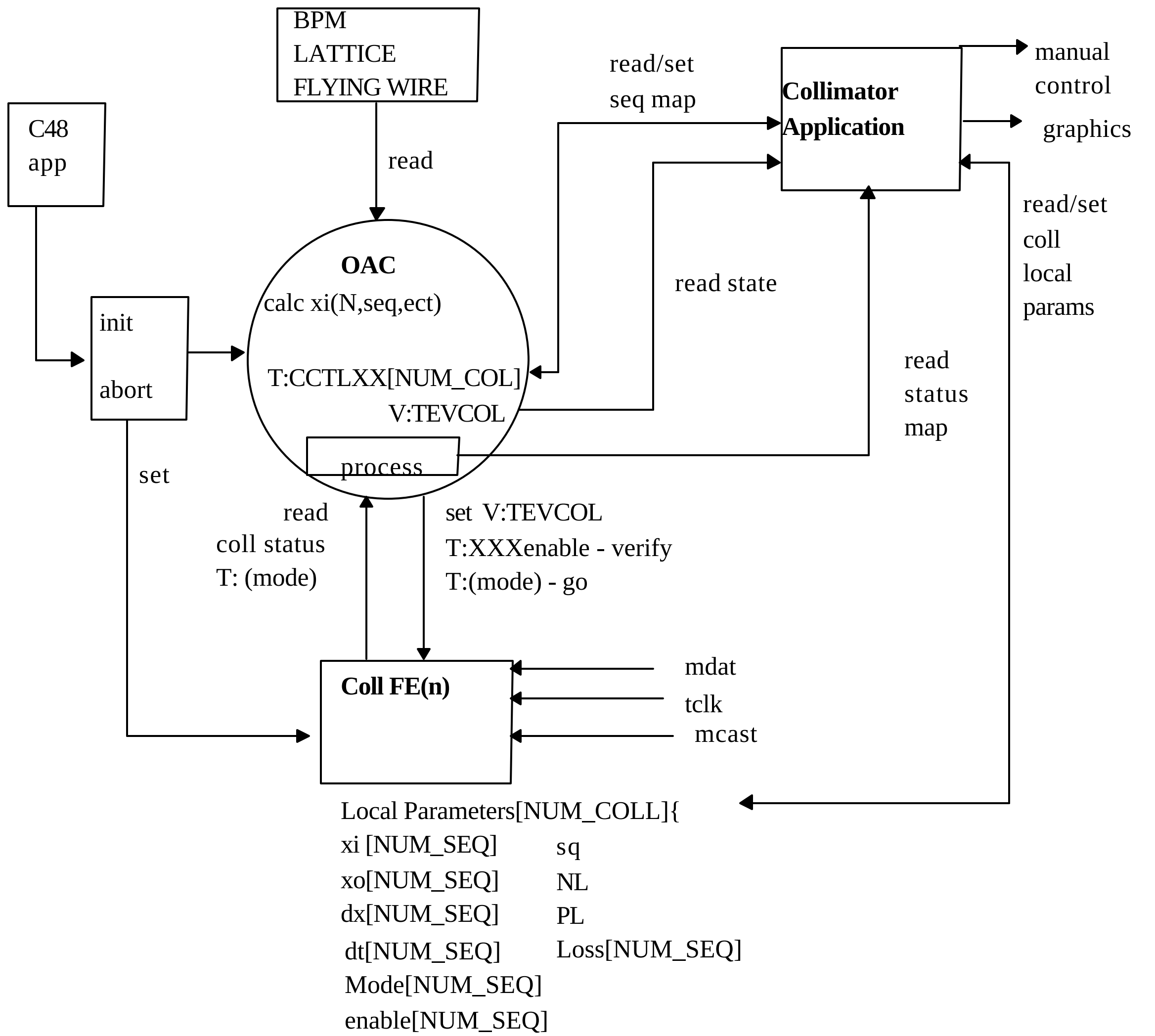
Application

Configure/view, Initiate Process:

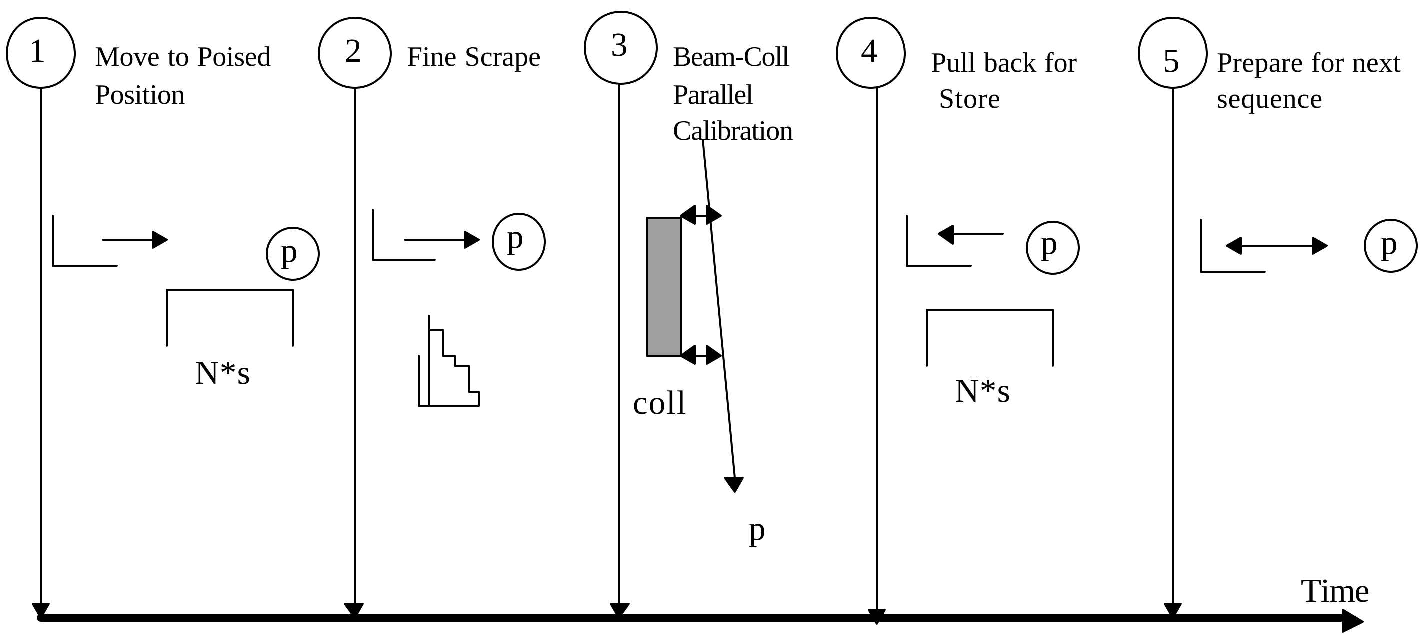
Can use sequencer initiate scraping.

Collimator Controls Block Diagram

Collimator Global Controls Layout

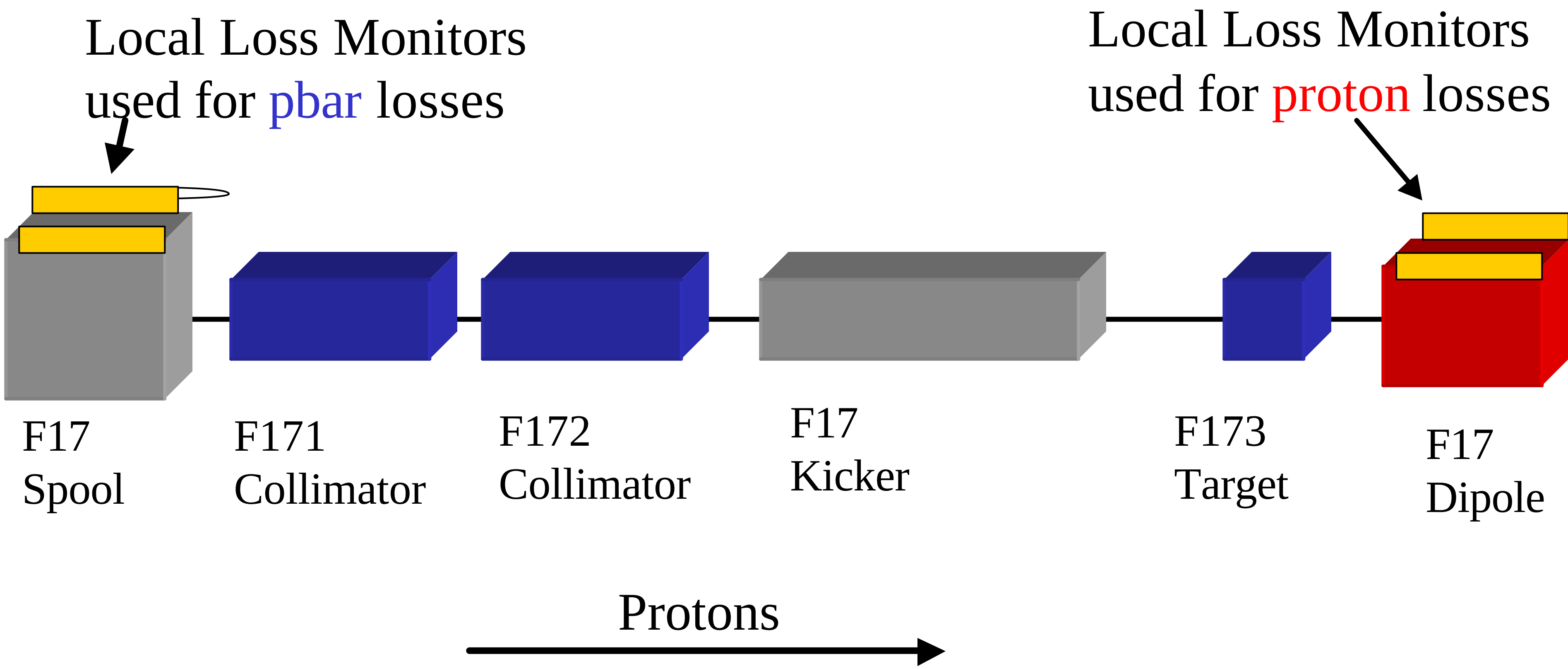


Collimator Moving Order for Halo Removal

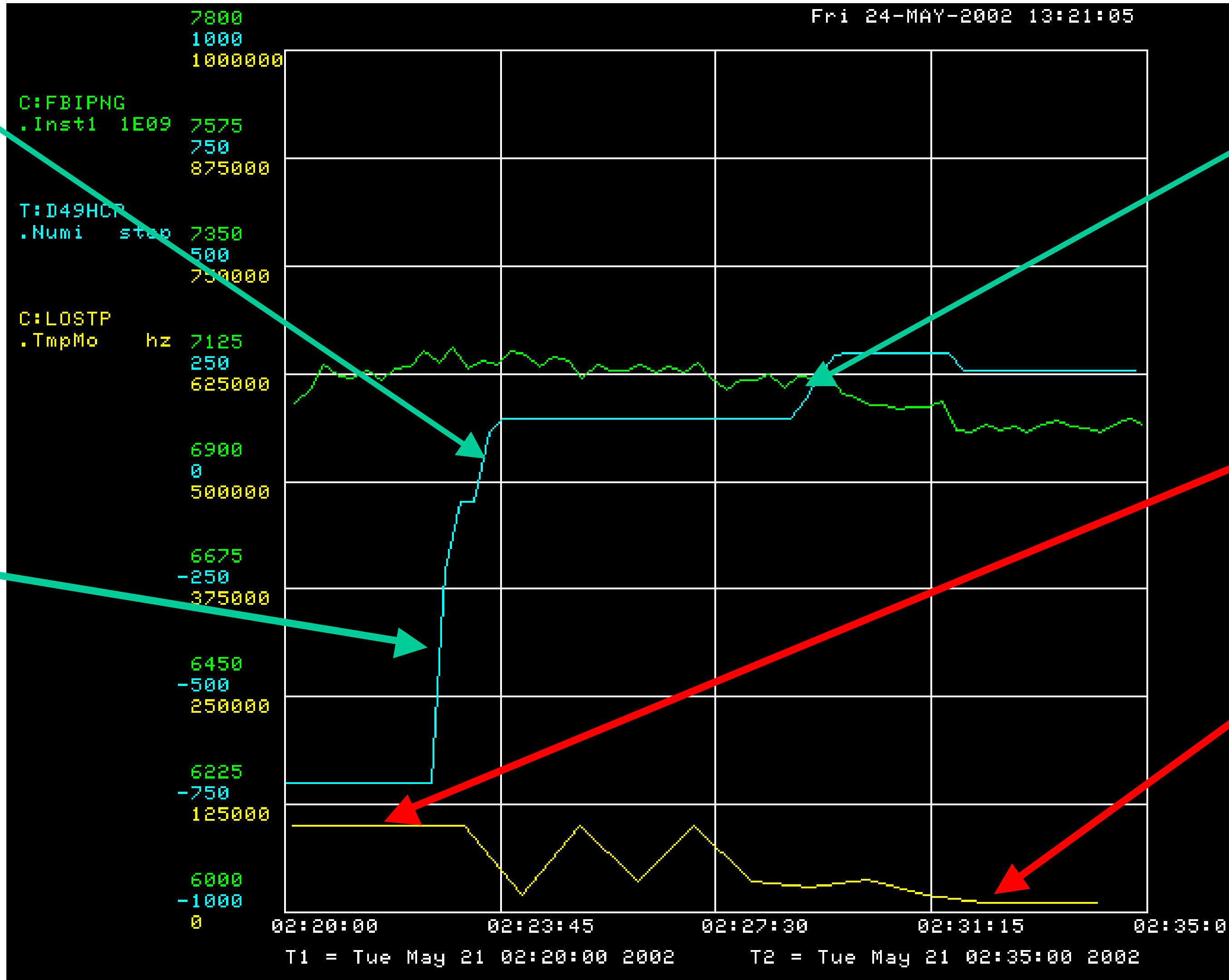


Sequence in Time of Collimator movement for Halo Removal

Tunnel Layout of Collimator Local Loss Monitors



Example of D49 movement during Halo Removal Process



Find the edge of the beam

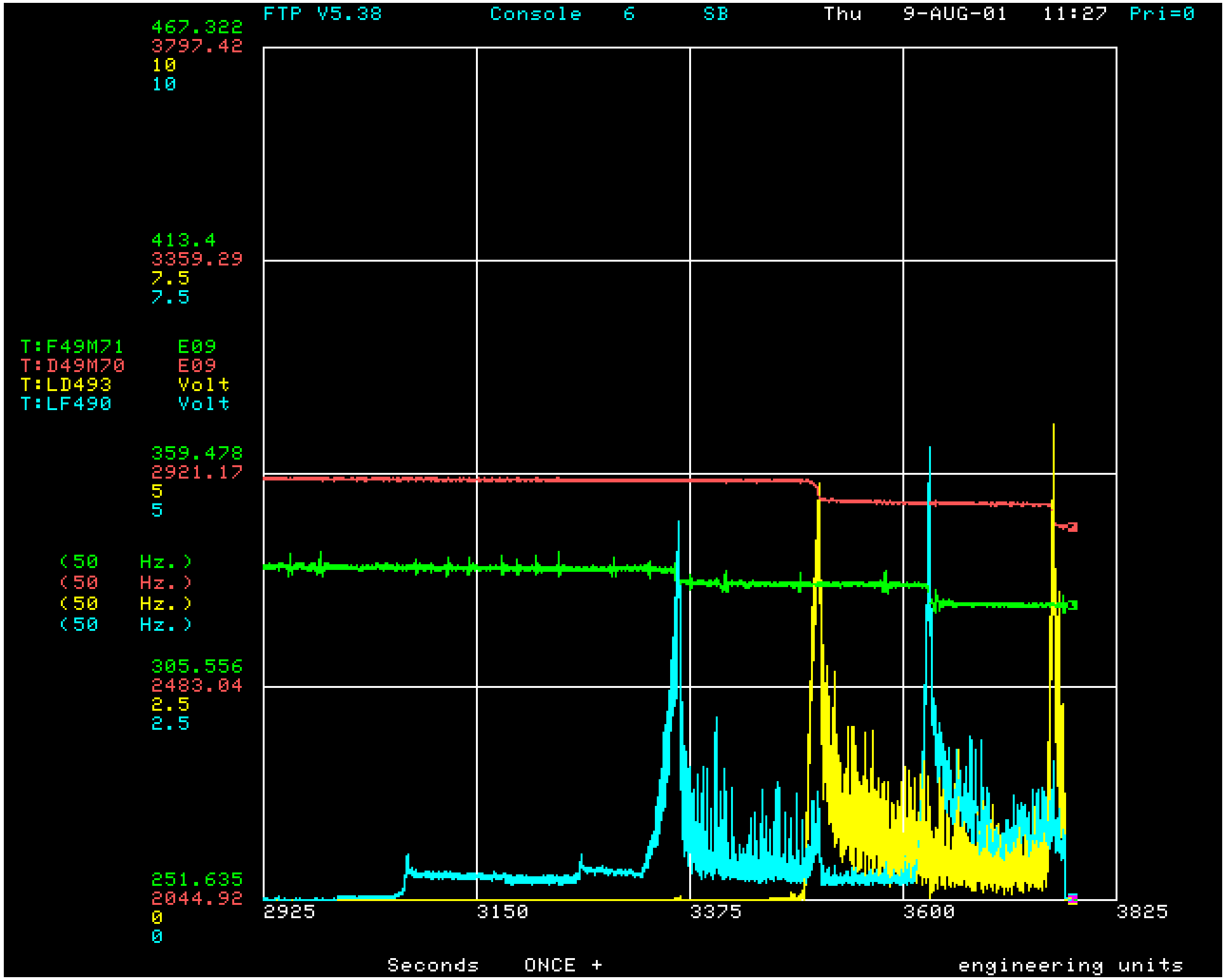
Initial Move
No feedback

Fine Scrape process:
Scrapes .4% of proton beam

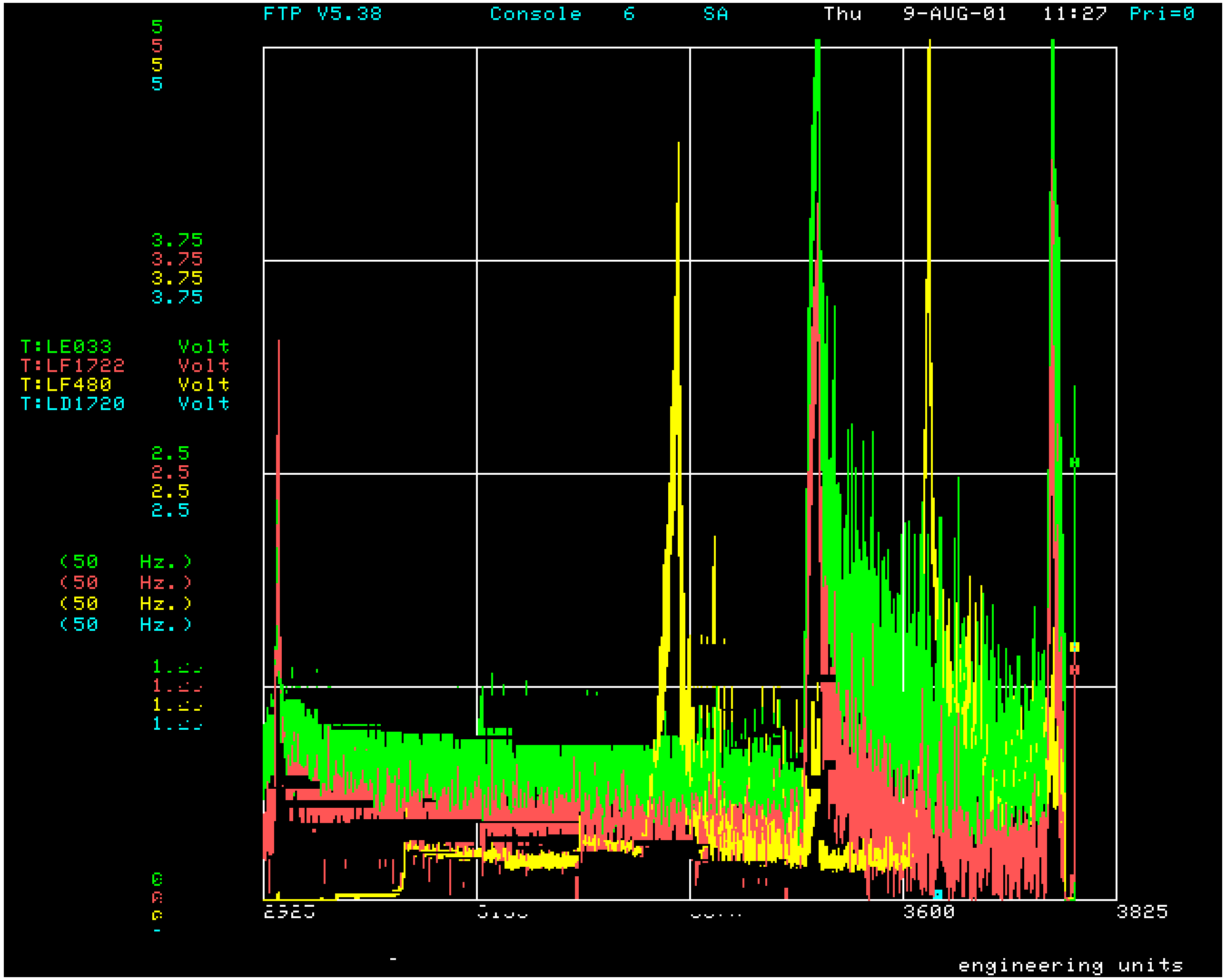
Before Halo removal CDF proton loss

After Halo Removal CDF proton loss

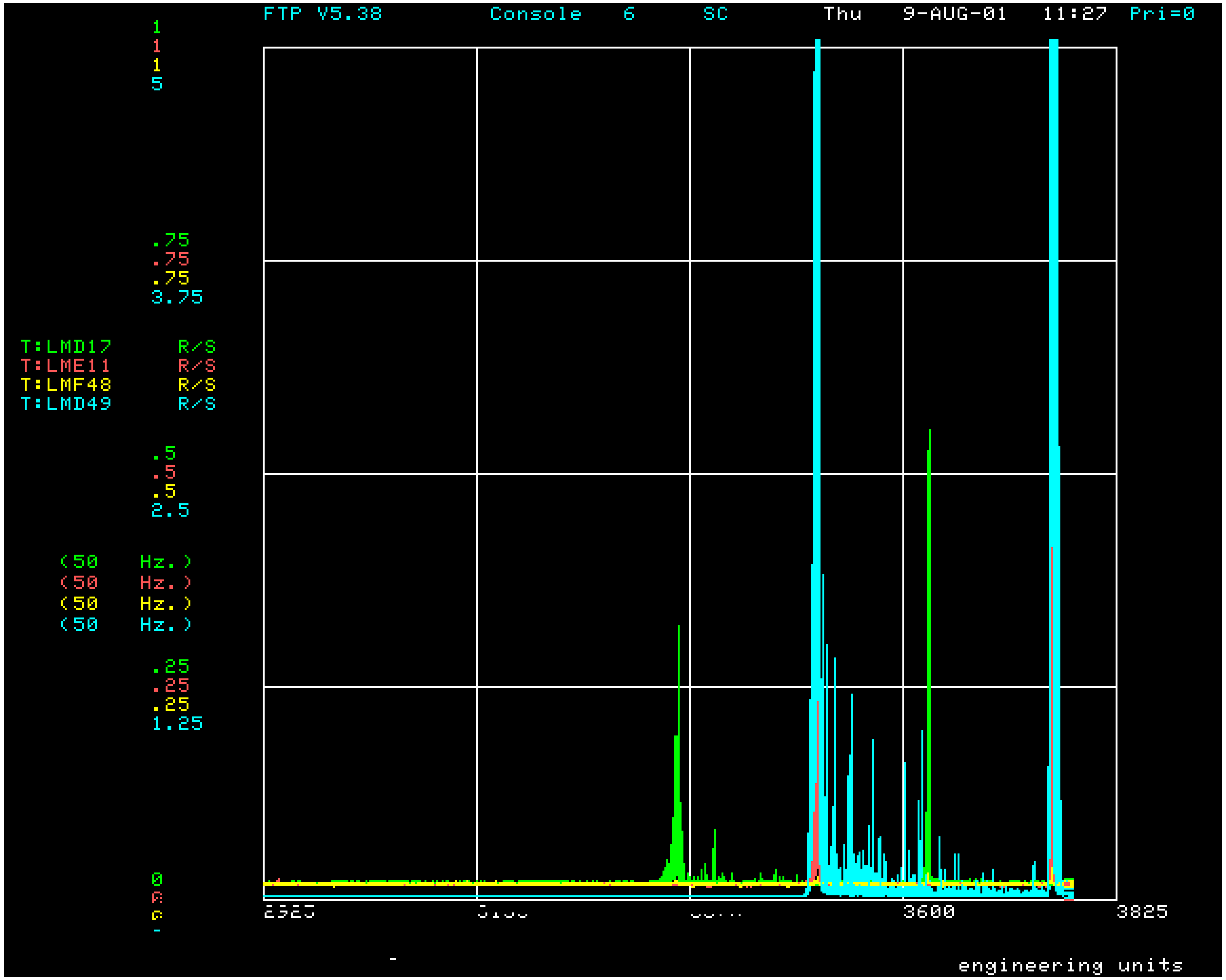
Proton & Pbar Targets moving during Halo Removal



2nd Collimator loss Plot during Halo Removal



Cold Magnet loss Plot during Halo Removal



Summary of Halo Losses During Stores

- D0 proton Halo losses are not effected by scraping.

- CDF and D0 report high proton rates in pots in bay.

- CDF reports large losses in muon chambers due to proton halo.

- CDF proton halo losses develop “spikes” due to “DC” beam.

- Losses that are attributed to power supply failures at CDF.

Studies Conducted to Understand Problems

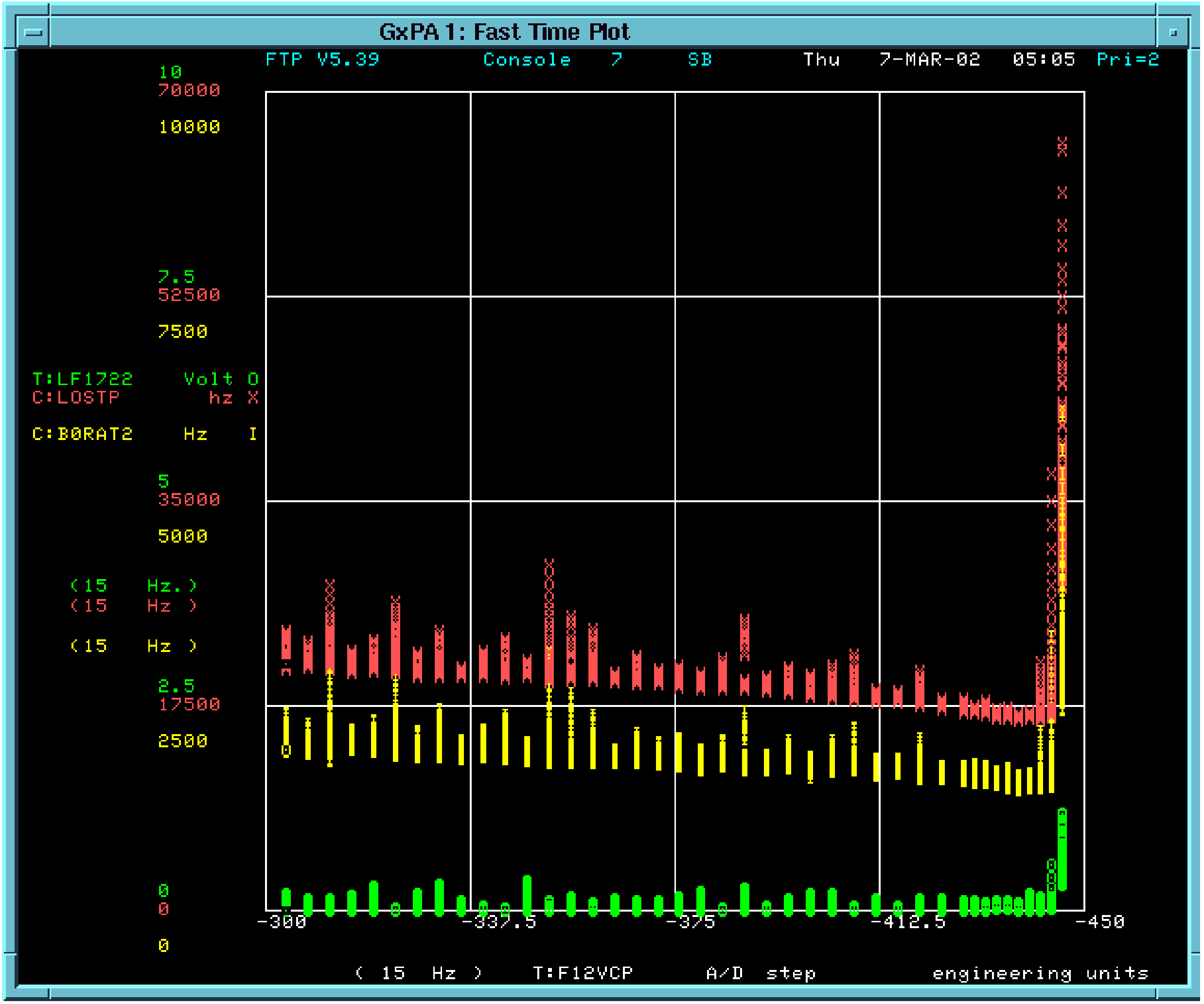
- ✓ Attempted to "tune up " the collimator system by verifing proper 2 stage collimator operation. The D49 target should be closer (5 σ) to the beam than the E03 and F172 collimators. ***Conclusion: No significant reduction (Refer to next 9 slides)***

- ✓ Run the electron lens now to remove the spikes on C:LOSTP and C:B0RAT2.

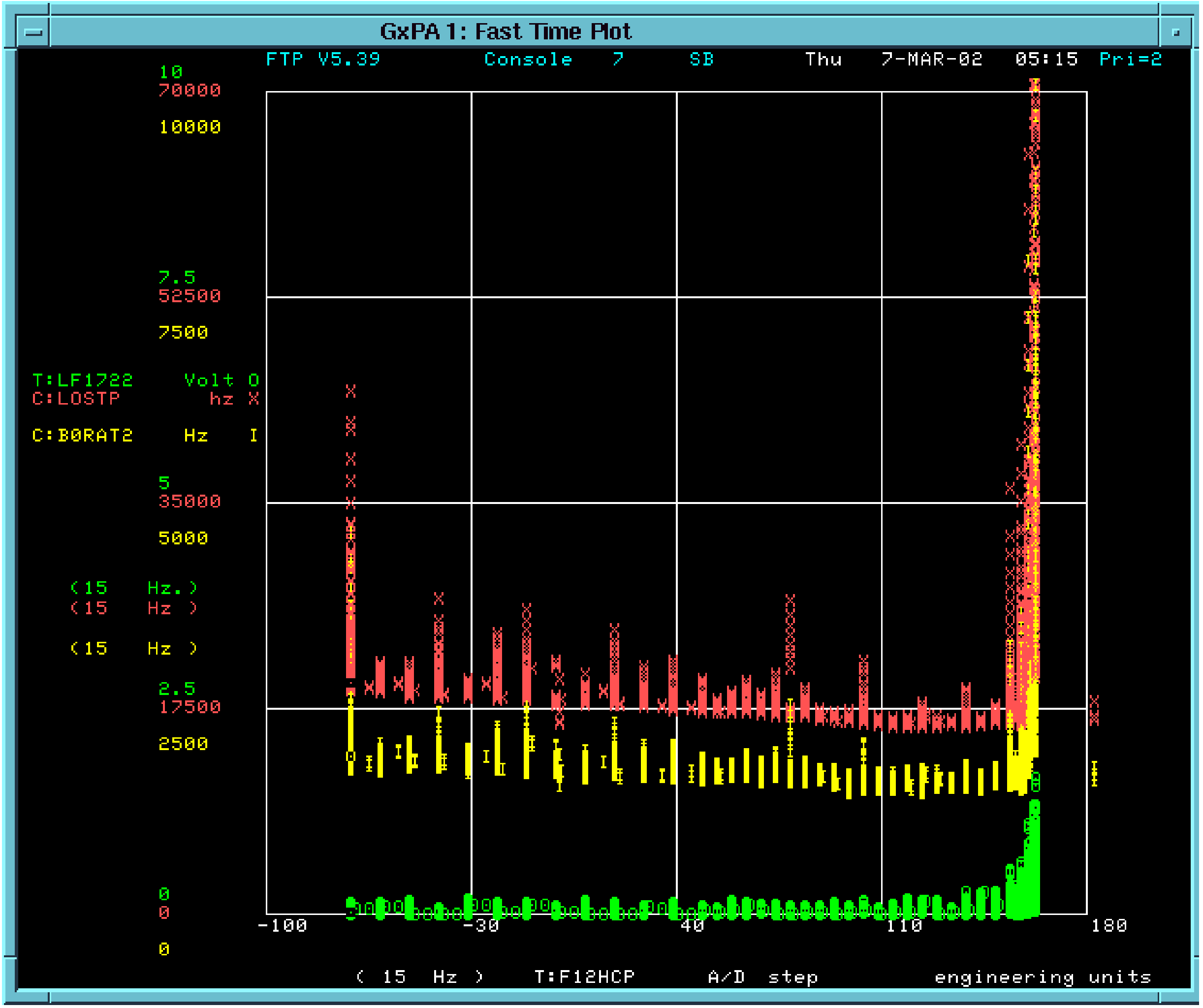
- ✓ Conduct a normal scrape during a store and then retract the D49 both planes completely out of the beam. ***Conclusion: No significant reduction.***

- ✓ Attempted to estimate the amount of loss due to scattering due to possible local poor vacuum. (Valeri Lebedev spoke on results)

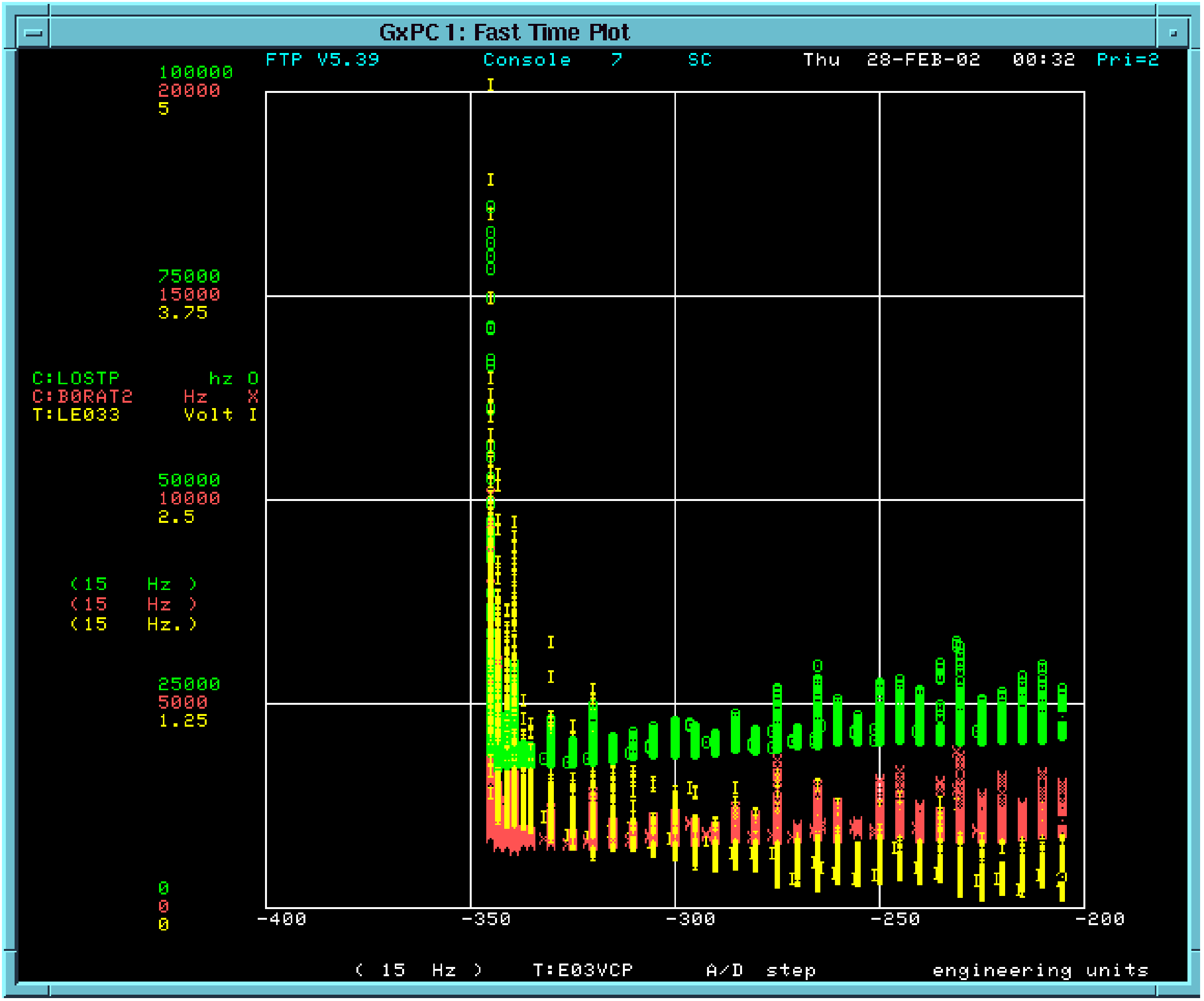
F172 Vertical Retraction Scan (with D49 target in)



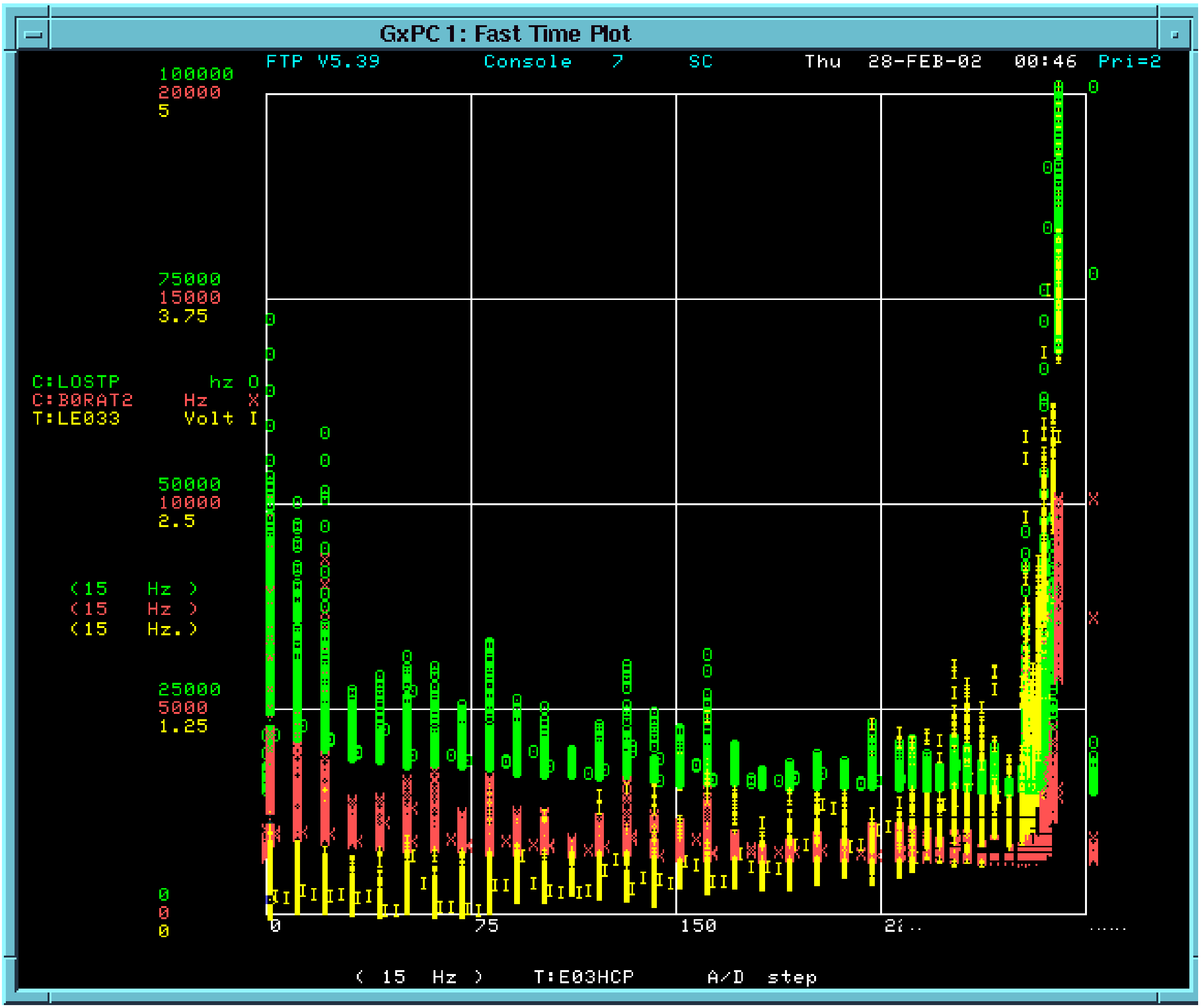
F172 Horizontal Retraction Scan (with D49 target in)

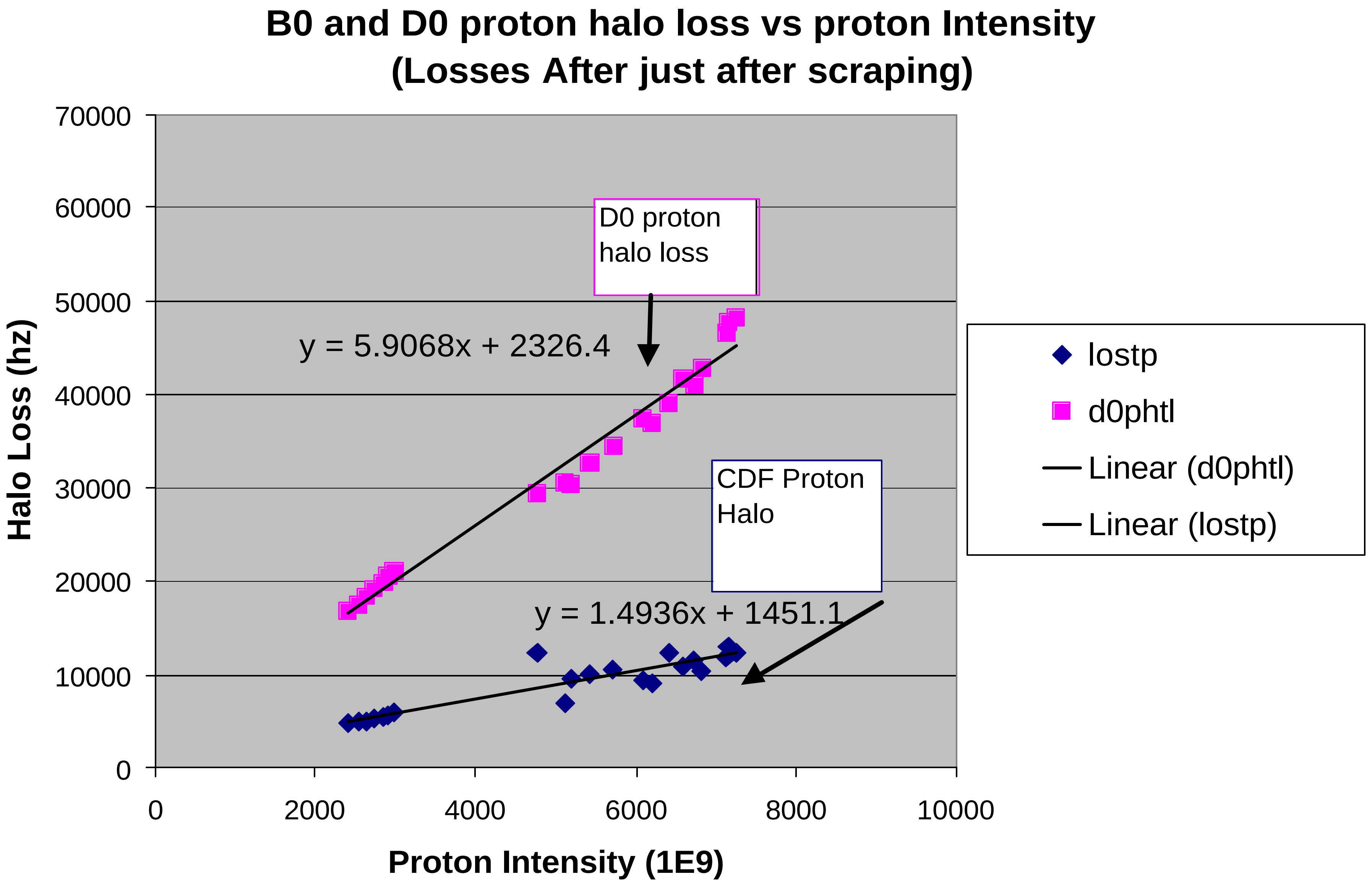


E03 Vertical Retraction Scan (with D49 target in)



E03 Horizontal Retraction Scan (with D49 target in)

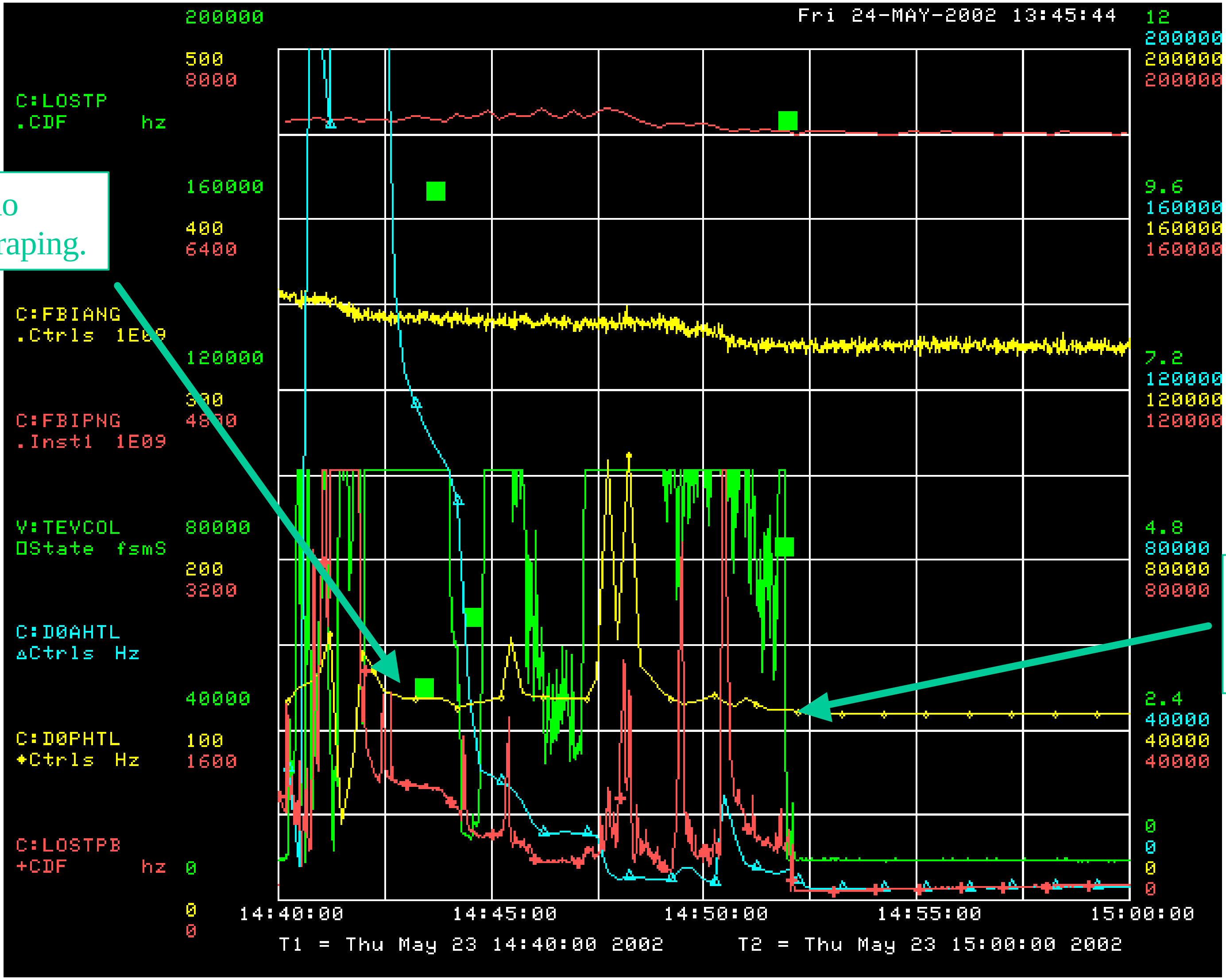




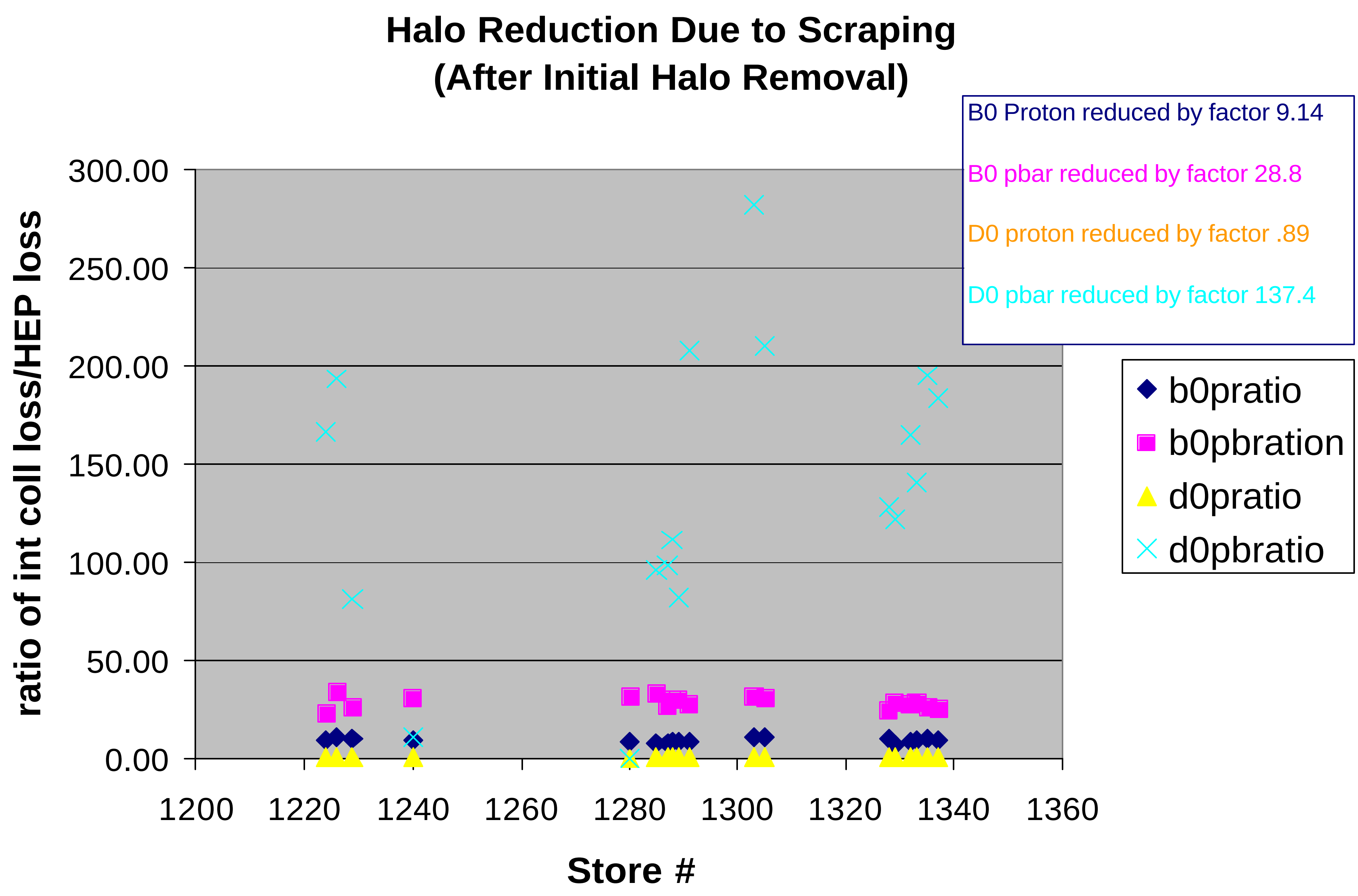
B0 and D0 proton halo loss vs proton Intensity
(Losses After just after scraping)
Halo Loss (hz)
70000
60000
50000
40000
30000
20000
10000
0
0
2000
4000
6000
8000
10000
Proton Intensity (1E9)
D0 proton halo loss
y = 5.9068x + 2326.4
CDF Proton Halo
y = 1.4936x + 1451.1
lostp
d0phtl
Linear (d0phtl)
Linear (lostp)

Merit of Halo Removal Effiency for Beginning of Store

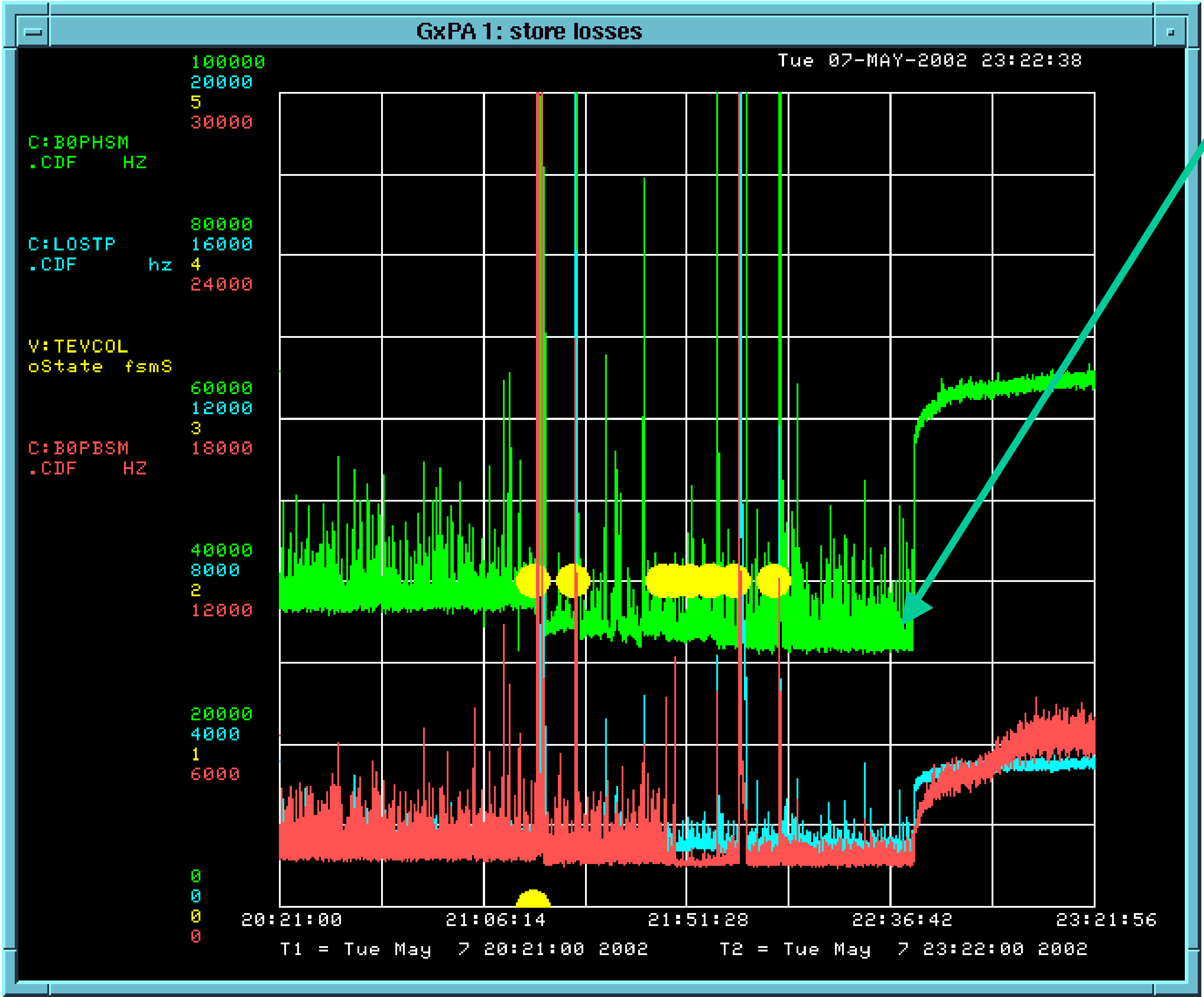
CDF and D0 Halo losses before scraping.



CDF and D0 Halo Losses after scraping


Halo Reduction Due to Scraping
(After Initial Halo Removal)
B0 Proton reduced by factor 9.14
B0 pbar reduced by factor 28.8
D0 proton reduced by factor .89
D0 pbar reduced by factor 137.4
b0pratio
b0pbration
d0pratio
d0pbratio
ratio of int coll loss/HEP loss
300.00
250.00
200.00
150.00
100.00
50.00
0.00
1200
1220
1240
1260
1280
1300
1320
1340
1360
Store #

Collimator Shielding Effiency for losses at End of Store



All Collimators Retracted at this point

End of Store Collimator Effiency

store	fbipng	fbiang	bop:12	b0p:14	b0pb:12	b0pb:14	d0p:12	d0p:14	d0pb:12	d0pb:14	b0pratio	b0pbration	d0pratio	d0pbratio
1291	4764	296	6848	12350	526	906	29260	29439	1746	4832	1.80	1.72	1.01	2.77
			b0pbsm											
			17050	44696							2.62			
1289	6503	289	9734	18523	1388	1902	23087	23266	13295	24030	1.90	1.37	1.01	1.81
			19736	69000							3.50			
1277	6480	82.2	22498.4	21623.4	2923.4	8848.4	35349	33420	20582	362.6	1.04	0.33	1.06	56.76
1229	5435.5	304.2	########	10173.4	72948	2748.4	32904	32648	#######	2036.7				

Studies Conducted to Understand Problems

- ✓ Changed order of E03 and F172 collimators during the halo removal process to remove the dead space in the E03H collimator upon retraction. ***Conclusion: Changing the order of the collimators resulted in ~ a 20% of C:LOSTP and C:B0RAT2.***

- ✓ The second proton collimator set was employed (horizontally coming from the radially outside) ***Conclusion: No reduction proton halo loss at all.***

- ✓ Conducted beam to collimator parallelism to see if a collimator was grossly misaligned to the beam. ***Conclusion: No significant reduction.***

Studies Conducted to Understand Problems

Problem 1) High proton losses at D0.

- ✓ Conducted horizontal and vertical angle bumps at D0 and B0 and horizontal and vertical 3 and 4 bumps at C0. We choose C0 because we know if we scrape at C0 the loss ends up at D0. ***Conclusion: No significant reduction of D0 proton halo loss.***
- ✓ Conducted long and short arc seperator bumps to see if it could be determined if the loss was due to C0 (the short arc) or losses coming from the long arc. ***Conclusion: No significant reduction of D0 proton halo loss.***
- ✓ Scraped proton only and proton-pbars repeately to see the effects. ***Conclusion: Found that B0 and D0 proton halo loss is a function of proton beam intensity. (See Fig.1 and Fig 2)***
- ✓ Conducted beam to collimator parallelism to see if a collimator was grossly misaligned to the beam. ***Conclusion: No significant reduction of D0 proton halo loss.***

Studies Conducted to Understand Problems

Problem 1) High proton losses at D0.

- ✓ Conducted horizontal and vertical 3 bumps across C0 with the D0 roman pots in the beam and looked at the pot loss rates vs. bumps. ***Conclusion: Able to reduce some Roman Pot loss rates by upto ~20%. D0 proton halo rates were not effected.***

- ✓ The second proton collimator set was employed (horizontally coming from the radially outside) ***Conclusion: No reduction of D0 proton halo loss at all.***

- ✓ Conducted C0 hor and ver 4 bumps while looking at D0 Roman Pots loss rates. ***Conclusion: Reduction of ~20% in certain pot channels (Fig. 3).***